

American Universities Field Staff**REPORTS
SERVICE**PROPERTY OF THE
LIBRARY OF THE
11 1960MAN'S COLLEGE
UNIVERSITY OF NORTH CAROLINA**A NOTE ON THE POLAR REGIONS**

by John Hanessian, Jr.

August 27, 1960

The Soviet Union and North America face each other across an intervening Arctic Ocean, direct crossing of which affords the shortest route from either to the heart of the other. In reaction to the fear engendered by this simple geographical fact the United States and Canada have found it necessary to establish and jointly maintain chains of detection stations running across the American Arctic. The Soviet Union operates a vast network of over 100 Arctic research and meteorological forecasting stations as an adjunct of its rapidly growing use of the Northern Sea Route. On both sides of the Arctic, polar aviation has spurred forward in just a few years.

At the opposite end of the globe is a great inhospitable, frigid continent of 5 1/2 million square miles (larger than Europe and the United States combined) almost entirely covered with a mantle of ice, some of which is 10,000 feet thick. Yet, despite these facts, Antarctica has become in the past four years the center of a multinational activity on a scale a hundred times greater than that of 20 years ago.

This astonishing surge of activity has, of course, been emphasized by the International Geophysical Year, but the average observer may wonder why so many nations seem prepared suddenly

[JH-3-'60]

to provide so lavishly for scientific and other activity in such uninhabited and distant areas, which for so many centuries received attention only from explorers and seafarers.

The motives prompting current polar activity might perhaps be divided into several classes: (1) strategic; (2) political; (3) scientific; and (4) economic. The spirit of personal adventure and curiosity, so essential to the success of past polar expeditions, has in a comparatively short time been replaced by the more pragmatic considerations of national public policy. That such policy is benefiting science there is no doubt; yet, much as it might be desirable, the needs of basic scientific research are not yet dictating the choice and scope of national activity in the polar regions.

If, as it has often been said, the "heroic" age of polar exploration and activity passed away with the onset of the airplane, the activities of the past 15 years amply demonstrate that another hallowed aspect of polar exploration has quietly passed into oblivion: personal expeditions backed by private funds. Today, practically all polar operations are financed by national parliaments acting on behalf of national policy.

Instead of spasmodic attempts to gather personal glory or superficial scientific data, current polar activities represent years of careful planning by a multitude of government and private organizations all as part of a continuing long-range program. Some dozen nations have established various forms of public agencies, institutes, and expeditionary organizations to plan and execute polar operations.

Strategic Considerations

Inevitably, the requirements of national security have assumed a paramount position in the choice of Arctic operations on both "sides" of the North Pole. The existence of the huge and well-equipped United States strategic air base at Thule in northwest Greenland¹ (910 miles from the North Pole) and at Nord in the far north, together with the jointly-manned (United States and Canada) chains of stations of the Distant Early Warning (DEW) Line running across the far north of Canada well within the Arctic Circle (most are at about 70° North latitude) with extensions into the Aleutians and Greenland, the Mid-Canada Line at about 55° North latitude, and the Pine Tree System radar picket fence² all testify to the strategic importance given to the Arctic by the North

¹ All United States military activity in Greenland is covered by agreements made during the past ten years with Denmark, whose sovereignty over Greenland the United States fully recognizes. The Copenhagen agreement of April 27, 1951, first placed Thule under terms of "common defense."

² All of these warning posts are linked instantaneously with NORAD (North American Air Defense Command) Headquarters in Colorado Springs.

American governments. It is more than probable that the Soviet Union has established a parallel network of detection stations.

The United States Navy is planning for the possibility of interfleet and fleet-to-mainland nuclear missile warfare in Arctic waters. The recent successful launching of the Polaris missile from a submerged submarine demonstrates the terrible devastation that might be caused by nuclear submarines passing under the Arctic ice to within striking distance of the opposite mainland.

Until recently most of the Arctic defense activity was based on the assumption that the main potential danger was aerial. But, the recent activities of American nuclear submarines³ in traversing the Arctic basin beneath the ice (culminating in the 850-mile voyage of the "U.S.S. Seadragon" under the ice of the Northwest Passage in August 1960) leaves little doubt of the ability of modern nuclear submarines (and probably ice-breakers now on the drawing boards⁴) to transport men and materials across the Arctic at any time of the year.

The strategic importance of the Antarctic is less simple to illustrate. The most obvious example concerns the Drake Passage, the 700-mile wide channel between Cape Horn and the South Shetland Islands. It has often been noted by American and British authorities that if the Panama Canal is ever blocked in time of war, shipping would be forced to use the southern route around the tip of Tierra del Fuego.

During a war the control of the Drake Passage, the one constriction in the globe-encircling Southern Ocean, could become of great importance. Among the South Shetland Islands immediately to the south of the Passage is Deception Island, on which all three claimants to the area, Argentina, Britain, and Chile, have bases. It affords the sole near-continental site for any form of Antarctic naval base⁵ or other substantial military establishment. The

³ In August 1958, the "U.S.S. Nautilus," after submerging in the Bering Strait off Alaska, became the first submarine to traverse the Arctic Sea when it resurfaced near Iceland four days later. At the same time the "U.S.S. Skate" traveled under the ice to the North Pole, and again repeated its performance under more difficult winter conditions in March 1959. In February 1960 the "U.S.S. Sargo" traveled under the Arctic ice from the west.

⁴ To date the highest reported latitude ever reached by surface ship is 83°21' North (at longitude 53°11' East) by the elderly Russian ice-ship "Fedor Litke" in September 1955.

⁵ The primary United States base on Hut Point at McMurdo Sound on the other side of the Antarctic continent has no ice-free runway and no usable harbor. The nearest feasible site for year-round aircraft operations is at Marble Point, some 80 miles across the Sound. Estimates for building a substantial airfield at this site vary from \$50 million to \$300 million.

harbor is moderately free of ice for most of the year, and there is ample ice-free land space for the construction of an air base.

Political Motives and International Law

National prestige and pride have long played an important role in polar activities. These political motives today are concerned with the establishment and maintenance of claims to territory. The "sector principle," first developed by a Canadian in 1907⁶ relative to staking out a pie-shaped claim in the Arctic terminating at the North Pole, and based on the concept of geographical contiguity, has also been adopted in amended form by all seven claimants to Antarctic territory. Five of these claimants (Australia, France, New Zealand, Norway, and the United Kingdom) mutually recognize each others' claims. In addition both Argentina and Chile claim territory which overlaps the British claim.

Most of the claims to these Antarctic "sectors" are based on several elements required by international law: (1) priority of discovery; (2) the making of a formal claim; and (3) the "effective" occupation of the territory coupled with the provision of administrative control. In addition Argentina and Chile have invoked the highly controversial principle of geological continuity as well as references to the 15th-century Papal Bulls.

From a legal point of view, the polar regions, as they are uninhabited for the most part, have always been regarded as terra nullius, and thus open to occupation by any nation. According to the present development of international law a nation does not establish sovereignty over a region merely by sending scientific expeditions or even by establishing a few isolated stations.

It has long been established that "effective" occupation is a prerequisite to the right of sovereignty and must accompany territorial claims. Although it may be difficult to define the term "effective" when applied to polar areas because of the rigorous climate and geographic conditions⁷ it is quite clear that the International Court would be unable to uphold claims to large areas of totally unexplored territory merely because of the discovery of a coast or the establishment of a coastal station.

⁶ M. P. Poirer while speaking before the Canadian Senate on February 20, 1907.

⁷ For example in the East Greenland Case (Denmark-Norway) decided by the Permanent Court of International Justice in 1933, it was said that "it is impossible to read the records of the decisions cases as to territorial sovereignty without observing that in many cases the tribunal has been satisfied with very little in the way of actual exercise of sovereign rights, provided that the other state could not make out a superior claim. This is particularly true in the case of claims to sovereignty over areas in thinly populated or unsettled countries."





INDEX OF ANTARCTIC STATIONS—1960

UNITED STATES

1. NAF. McMurdo Sound	Lat. 77° 51'S Long. 166° 37'E
2. Little America V	Lat. 78° 11'S Long. 162° 10'W
3. Byrd	Lat. 79° 59'S Long. 120° 01'W
4. Amundsen-Scott South Pole	Lat. 90° 00'S
5. Wilkes (Temporary Custody of Australia)	Lat. 66° 15'S Long. 110° 31'E
6. Hallett (Jointly with N.Z.)	Lat. 72° 18'S Long. 170° 18'E
7. Ellsworth (Temporary custody of Argentina)	Lat. 77° 43'S Long. 41° 07'W

ARGENTINA

8. General Belgrano	Lat. 77° 56'S Long. 38° 29'W
9. Orcadas	Lat. 60° 45'S Long. 44° 43'W
10. Melchior	Lat. 64° 20'S Long. 62° 59'W
11. Primero de Mayo	Lat. 62° 59'S Long. 60° 43'W
12. San Martin	Lat. 68° 08'S Long. 67° 07'W
13. Almirante Brown	Lat. 64° 53'S Long. 62° 53'W
14. Esperanza	Lat. 63° 16'S Long. 56° 49'W
15. Teniente Camara	Lat. 62° 36'S Long. 59° 57'W

AUSTRALIA

16. Mawson	Lat. 67° 36'S Long. 62° 53'E
17. Davis	Lat. 68° 34'S Long. 77° 58'E

BELGIUM

18. King Baudouin	Lat. 70° 26'S Long. 24° 19'E
-------------------	---------------------------------

CHILE

19. Bernardo O'Higgins	Lat. 63° 19'S Long. 57° 54'W
20. Gonzalez Videla	Lat. 64° 49'S Long. 62° 52'W
21. Arturo Prat	Lat. 62° 29'S Long. 59° 38'W
22. Aguirre Cerda	Lat. 62° 56'S Long. 60° 36'W

FRANCE

23. Dumont D'Urville	Lat. 66° 40'S Long. 140° 01'E
----------------------	----------------------------------

JAPAN

24. Showa	Lat. 69° 00'S Long. 39° 35'E
-----------	---------------------------------

NEW ZEALAND

25. Scott	Lat. 77° 50'S Long. 166° 44'E
26. Hallett (jointly with U.S.A.)	Lat. 72° 18'S Long. 170° 18'E

NORWAY

27. Norway Base (Temporary custody of South Africa)	Lat. 70° 30'S Long. 02° 52'W
---	---------------------------------

POLAND

28. Oazis (To be Re-est. 1960)	Lat. 66° 16'S Long. 100° 44'E
--------------------------------	----------------------------------

U.S.S.R.

29. Mirny	Lat. 66° 33'S Long. 93° 00'E
30. Lazarev (Est., 10 Mar. 1959)	Lat. 69° 56'S Long. 12° 58'E
31. Komsomalskaya	Lat. 75° 00'S Long. 93° 00'E
32. Vostok	Lat. 78° 27'S Long. 106° 52'E
33. Sovietskaya	Lat. 78° 24'S Long. 87° 35'E
34. Pole of Inaccessibility	Lat. 82° 06'S Long. 55° 00'E

UNITED KINGDOM

35. Halley Bay	Lat. 75° 31'S Long. 26° 36'W
36. "A" Port Lockroy	Lat. 64° 50'S Long. 63° 30'W
37. "B" Deception Island	Lat. 62° 59'S Long. 60° 34'W
38. "D" Hope Bay	Lat. 63° 24'S Long. 56° 59'W
39. "F" Argentine Island	Lat. 65° 15'S Long. 64° 16'W
40. "G" Admiralty Bay	Lat. 62° 05'S Long. 58° 25'W
41. "H" Signy Island	Lat. 60° 43'S Long. 45° 36'W
42. "J" Ferin Head	Lat. 66° 00'S Long. 65° 24'W
43. "Y" Horseshoe Island	Lat. 67° 49'S Long. 67° 17'W

Additional Sub-Antarctic Stations (Not Shown on Map)

Macquarie Island (Australia)	54° 29'S, 158° 57'E
Kerguelen Island (France)	48° 40'S, 69° 14'E
Campbell Island (New Zealand)	52° 32'S, 168° 59'E
Marion Island (South Africa)	46° 53'S, 37° 52'E
Gough Island (South Africa)	40° 19'S, 19° 54'W
South Georgia (U.K.)	54° 16'S, 36° 31'W

On September 29, 1916, the Russian Government issued a declaration stating that several islands north of the Siberian mainland were to be regarded as part of the Russian Empire on the grounds that they form "the northern continuation of the Siberian continental shelf." Then, on April 15, 1926, the Soviet Government employed the sector principle as a basis for territorial claims in the Arctic. On June 10, 1925, the sector principle was invoked for Canada for all "lands" between the Canadian coast and the North Pole.

In Antarctica the Soviet Union⁸ and the United States⁹ have manifested the same policy regarding claims. Neither state has instituted a formal claim nor do they recognize existing claims of other states. This remarkable coincidence of political policy was in large measure responsible for the successful conclusion of the 1959 international Antarctic Conference in Washington and the signing of the Antarctic Treaty [see The Antarctic Treaty (JH-2-'60), an AUFS publication].

Scientific Research

The International Geophysical Year¹⁰ carried out during 1957-58 by 66 nations has nicely demonstrated that the need for fundamental research is a powerful force in international affairs. Some 30,000 scientists and technicians carried out concurrent measurements of geophysical phenomena at over 4,000 principle scientific stations. Although these observations were conducted throughout the entire world, special emphasis was placed on the polar regions from the very beginning of the planning in 1952.

The response to this emphasis was astounding. In the Antarctic and sub-Antarctic scientific work was carried out by 12 nations¹¹ at over 60 stations, most of which were established specifically for the IGY; in the Arctic four stations were established by the United States and the Soviet Union on the drifting ice of the central basin, and work was conducted by many nations at scores of stations in Spitzbergen, Greenland, and in the Soviet and American Arctic.

⁸ Unlike the United States, whose citizens have participated in considerable Antarctic activity since the early 19th century, the only expedition from Russia until 1955 which could supply any basis for claim was Bellingshausen's famous voyage of Antarctic circumnavigation in 1819-21.

⁹ Yet, the United States, until very recently, scarcely discouraged its subjects from making claims on its behalf.

¹⁰ A successor to the International Polar Years of 1882-83 and 1932-33.

¹¹ Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, United Kingdom, United States, and the Soviet Union.

It was tacitly agreed that political activity in the polar areas would be waived during the IGY, an arrangement which was closely observed. International co-ordination of scientific programs and the placement of stations was successful to an extraordinary degree.¹²

This international co-operation worked so well that before the IGY had been terminated an international Special Committee on Antarctic Research (SCAR) had been established to co-ordinate Antarctic research on a long-term basis. It seems more than likely that a similar arrangement will be worked out for the Arctic. It is worth noting that this successful co-operation created an atmosphere of good will that was actually strong enough to break down long-standing national attitudes and helped bring about the Antarctic Treaty.

The scientific results of the IGY work in the polar regions are continuing to pour in to the World Data Centers, which were specially created for that purpose. These data are available to any scientist or scientific organization. Polar observations have been especially valuable in the fields of meteorology, auroral and ionospheric behavior, geomagnetism, and glaciology. For the first time in history synoptic weather information was available on a global basis, and the work accomplished in high altitude atmospheric circulation has changed many of the older theories.

Economic Possibilities

Although economic considerations, except for sealing and pelagic whaling, have been almost absent in Antarctic history, they have provided the incentive for almost all early exploration in the Arctic. The centuries-old hunt for the mystical northeast and northwest passages was primarily based on the hope of finding a short route from Europe to the riches of the Orient.

In the Arctic both the Soviet Union and Canada are currently expanding programs to tap the huge reservoirs of proven mineral wealth. Antarctica presents another picture. The forbidding nature of the continent has almost completely prevented geologic exploration. No signs of economic worth have been sufficient to stimulate enterprise on the southern continent. Whatever mineral wealth Antarctica may hold (and there is much evidence pointing to considerable deposits) it is certain to remain locked up under the almost impenetrable ice sheet. Exploitation of the available ice-free areas is long likely to be less profitable than in more easily worked fields elsewhere.

¹² A typical example is the occurrence at the first IGY international conference on Antarctica held in Paris in 1955. The Soviet representatives reported that the Soviet Union planned to set up a station at the South Pole. When the conference chairman pointed out that the United States had already stated its intention of establishing a station at that site, the Russians gracefully withdrew, and later established their inland stations at locations complementary to that of the United States.

Quite apart from the ice, the problems of climate, isolation, the hazards of transport and the enormous costs that would be entailed hardly afford favorable circumstances for exploitation. Yet, it must be recognized that the discovery of metallic gold or other rare or strategic minerals might well alter the entire situation.

Other considerations should also be mentioned. For example, with the world's population increasing some 50 million annually, the fact that the polar regions comprise one-seventh of the total land surface of the world is beginning to assume striking significance.

The astonishing development by the Soviet Union of the Northern Sea Route is a reminder that harsh conditions will not prevent the development of transport and trade so long as economic advantages are obvious. That route along the Arctic shore of the Eurasian land mass sees the annual transport of over a million tons of cargo. A highly developed weather and ice forecasting service based on aerial reconnaissance and regular observations from the chain of Soviet Arctic stations along the route emphasize the value the Soviet Union places on this service.

The recent exploits of American nuclear submarines have opened up extraordinary commercial possibilities for the Arctic. For example, cargo submarines passing through the Arctic Sea would reduce the present shipping distance from the Far East to Europe by 6,000 miles. Submarine tankers could deliver Canadian oil directly to the European market.

In the past one of the many severe handicaps in exploiting the polar regions has been the necessity to transport bulky fuel over long distances. The recent successful development by the United States of a small-scale nuclear reactor for the production of electric power¹³ will revolutionize polar operations and for the first time open up possibilities of permanent settlement. The Atomic Energy Commission has already contracted for the construction of several such "packaged power plants" which Congress authorized for use at United States scientific stations in Antarctica.

Trans-Polar Air Routes

The recent commercial development of air routes over the Arctic has proved to be an outstanding success. It has long been known that in the heavily populated Northern Hemisphere, great circle routes between important areas

¹³ On August 13, 1958, the Argonne National Laboratory operated by the University of Chicago for the AEC announced the successful testing of a prototype reactor. The unit is designed to produce 3,000 thermal kilowatts and require refueling only once every three years. The reactor is an air-cooled, direct-cycle, natural circulation type requiring few installation problems. All components are easily transportable by air.



and cities pass through very high latitudes. The search for practical and usable short cuts along these routes between Europe and the American West Coast and the Far East has continued for 400 years. Resourceful men, such as Columbus, John Cabot, Henry Hudson, Martin Frobisher, and Fridtjof Nansen, are among those who have participated in the hunt.

Roald Amundsen, the conqueror of the South Pole, was the first to cross the Arctic by air--from Spitzbergen to Teller, Alaska (3,390 miles) with a dirigible in May 1926 in a 72-hour flight. But, it was not until the last years before the outbreak of World War II that the first serious attempts were made to begin a commercial trans-polar air service. This was done by the Russians who, for several decades, had been gathering knowledge of Arctic flying techniques, and who had established by air a floating research station on an ice floe near the North Pole in 1937.

In the summer of 1937 in two spectacular flights, first Chakalov and then Gromov flew nonstop from Moscow over the North Pole to Vancouver and San Jacinto, California, respectively, the latter flight covering a distance of 7,000 miles in 62 hours. These flights were made in single-engined aircraft with three-man crews.

Although the war stopped all plans for developing trans-polar air operations, the rapid technical development of aviation during these years greatly improved conditions for the future introduction of such flights. Furthermore, Arctic airfields were constructed in Labrador (Goose Bay), Baffin Land (Frobisher Bay), Hudson Bay, and in Greenland (B.W. 1 and B.W. 2).

In 1947 the United States Air Force began an extensive series of "Ptar-migan" weather flights from Alaska to the North Pole. Over 2,000 such flights have now been made with a resultant vast increase of knowledge of Arctic flying. Meanwhile, the Russians were pioneering Arctic history with an extensive number of landings made all over the Arctic ice pack.

Then followed two Arctic flights which received considerable publicity and heralded the imminent introduction of regular trans-polar flights: the Arctic pioneer Bernt Balchen's flight direct from Fairbanks, Alaska, to Oslo in 1949 and Captain Blair's solo flight in a Mustang single-seater fighter from Bardufoss, Norway, to Fairbanks in 1951 via the North Pole.

In 1951 the Danish Foreign Office requested the United States State and Defense Departments for permission to survey routes between Copenhagen and Los Angeles via Thule and the Canadian Arctic. The plans began to firm up when in November 1952 SAS routed a passenger-carrying Douglas DC-6B along the Scandinavian-United States West Coast route. This first flight was followed by additional successful SAS exploratory flights during 1952-54 including routes from Scandinavia to Tokyo, which enabled the company to gain sufficient experience in polar navigation and communications to begin scheduled services.

Finally on November 14, 1954, SAS flew its first scheduled flight over the polar route from Copenhagen to Los Angeles via Greenland and Winnipeg. This service was extended on February 27, 1957, to regular passenger service from Copenhagen to Tokyo via Anchorage, Alaska. In June 1955 Canadian Pacific Airlines commenced service from Sydney to Canada via the polar route.

For some reason American carriers expressed little interest and it was not until September 1957 that Pan American and Trans World Airlines commenced service from the West Coast to Europe. This service, however, is hardly "polar" as advertised, since the route never approaches within 1,500 miles of the North Pole. During 1958 and 1959 Air France and KLM also inaugurated polar service from Europe to Tokyo.

These new routes have enormously decreased flying distances and time. For example, the flight from Copenhagen over Norway, Spitzbergen, the North Pole, and Alaska to Tokyo is 8,202 miles and 31 hours while the alternative Copenhagen-Karachi-Tokyo route is 10,280 miles and 51 hours. An even shorter route would be to fly over Siberia. New jet aircraft should be able to fly nonstop over this 5,000 mile route from Scandinavia to Japan in ten hours.

Communications reliability and flying conditions on the Arctic routes have been found to be much more favorable than along the North Atlantic routes. From 1954-59 SAS flew via the Arctic more than 60,000 passengers and 1.5 million pounds of cargo, clearly showing the potential of trans-Arctic airline operations.

The now-routing flights over the Arctic have inevitably opened up discussions re trans-Antarctic commercial air routes connecting South Africa, Australia, New Zealand, and South America. Although it would be technically possible to develop such routes within a few years, especially if the tempo of Antarctic station activity continues, it may not be commercially feasible.

In the Southern Hemisphere populations are so small and the large cities are located in such relatively low latitudes¹⁴ that regular trans-Antarctic civil airline routes are not likely to develop for some time. Nevertheless, the United States Navy and Air Force have demonstrated since 1955 the feasibility of flying even two-engined aircraft to Antarctica from New Zealand and landing both on sea ice and on the icecap.

¹⁴ For example: Buenos Aires, Santiago, Melbourne, Sydney, and Capetown are all located between 34-37° South latitude. Even Wellington, New Zealand, the closest to Antarctica, stands almost 3,000 miles north of the South Pole. In contrast, the Northern Hemisphere is heavily loaded with high latitude population centers: Murmansk (68°), Fairbanks, Alaska, and Reykjavik, Iceland (65°), Oslo, Stockholm, Helsinki, Leningrad, Anchorage, Alaska (all about 60°), Moscow, Copenhagen, Edinburgh, and Edmonton, Canada (55°), and even Dublin, London, Brussels, Amsterdam, Berlin, and Warsaw are all substantially north of 50° North latitude.

Since then both the United States and the Soviet Union have used aircraft extensively in supporting field parties and in transporting supplies. The British Commonwealth Trans-Antarctic Expedition even flew a single-engined aircraft across the entire continent in 1957-58. In October 1957 Pan American flew a passenger plane from New Zealand to McMurdo Sound on a chartered Navy flight. The excellent communications and meteorological network in Antarctica has done much to expand flight operations over the continent.

Physiography and Climate of the Arctic

The polar regions are considered by most people to be essentially similar: frozen wasteland. Yet, the two regions have few characteristics in common, and are perhaps better understood by examining their contrasts. The "Arctic" is fundamentally an oceanic basin¹⁵ hemmed in by the Arctic extensions of the two most populous continental land masses of North America and Eurasia.

Antarctica, on the other hand, is a great ice-covered land. Surrounded by the Atlantic, Pacific, and Indian oceans, it is the highest land mass in the world with an average altitude of well over 5,000 feet. Antarctica has never supported life except at its very fringes, yet the Arctic provides food and raw materials for a growing and vibrant population.

Where is the Arctic? Popularly it is considered to be the area within the Arctic Circle (66° 30' North latitude), which is shown as a dotted line on most globes and maps. The line has almost no geographical significance; it simply delimits the area around the Pole where for at least one day each year the sun does not rise and for at least another day the sun does not set.

The sun actually has little to do with defining the Arctic. Crossing the Circle makes no difference to the appearance of the land, the sky, or the sea. Certainly all areas within it do not have the same climate. It is now generally agreed that the real boundary of the Arctic is the tree line, which in many places is far north of the Arctic Circle and in others it is hundreds of miles to the south. Usually the edge of tree growth is not marked by a sharp line; generally trees will not grow where the average temperature of the warmest month of the year is less than 50° F. Thus the tree line is also a temperature belt.

An extensive belt of land that borders the tree line on the south is called the "sub-Arctic." Several hundreds of miles wide and usually featuring dense coniferous forests, it acts as a transitional zone between the true Arctic and

¹⁵ The Arctic Sea is about 5.5 million square miles in extent--compared with 1.1 million for the Mediterranean Sea and 31.5 and 64.0 million square miles for the Atlantic and Pacific oceans respectively.

the temperate regions. Here the mean temperature rises above 50° F. during at least one but not more than four months annually.

The 'polar segment' of the Arctic is a term given to a colder portion of the area where the mean temperature of even the warmest month is less than freezing or 32° F. To visit the true Arctic one need go no further than Labrador. There in latitude 55° North one is beyond the tree line. On the other hand, in northwestern Canada it is possible to travel as far north as 68°, and in Norway to Hammerfest at 70°, and still be in wooded country.

In North America, usually included in the Arctic are the Northwest Territories, Yukon Territory, Labrador, Alaska, and Greenland, but not Iceland, for conditions there are not even sub-Arctic. For example, the average mean temperature of Reykjavik for the coldest month of the year is about the same as for Philadelphia. For similar reasons the western seacoast of Scandinavia is not included although the northern interior is--roughly Norwegian, Swedish, and Finnish Lapland.

Spitzbergen is in the Arctic, and further east in the Soviet Union is included a belt which is at first narrow but widens eastward to embrace large parts of the northern basin. To the north of these land masses are Arctic islands and further to the north they are separated by a mediterranean sea, which is navigable around its edges during the summer months. During winter the margins of the frozen sea are landfast.

Obviously latitude is not the only factor that controls the growth of vegetation and determines the climate; and cold does not necessarily increase as one travels north. Mountains, valleys, plateaus, prevailing winds, and ocean currents play a large part in varying Arctic climate.

The coldest settlement in the Northern Hemisphere is located 250 miles south of the Arctic Circle at Oymekon in northeast Siberia. Here the average temperature for February (the coldest month) is about -58° F. and the lowest temperature ever recorded is about -90° F. Yet, the warmest month at Oymekon averages 60° F., almost 120° difference. The area is remote from the moderating influence of the sea; thus when there is little wind, the cold air collects and gets colder.

The coldest temperature recorded in North America is nowhere near the Arctic Sea, but in the Yukon, where it had dropped to -83° F., but it also usually touches 80° F. in an average summer. Along the entire Arctic coast a temperature lower than -58° F. has never been recorded, yet five states in the United States (Minnesota, South Dakota, Wyoming, North Dakota, and Montana) have all recorded -55° F. or colder. The Arctic coastal station reporting the lowest average annual temperature¹⁶ is the Russian Mys Chelyus-

¹⁶ The Soviet Union regularly transmits meteorological information from its Arctic stations into the network of the World Meteorological Organization.

kina at 5⁰ F. It is located at the northeastern tip of the Eurasian mainland.

Very little rain or snow falls on the Arctic, and water might become scarce in summer if the permafrost did not prevent it from seeping away. Without this action the far north would be a lifeless desert. Annual precipitation in most parts of the Arctic is between 7 to 10 inches.¹⁷ Permafrost is the term used to describe the condition which exists when the subsoil is permanently frozen a few inches or a foot below the surface. The result is a lack of drainage, which causes the appearance of an incredible number of shallow lakes whenever there is level or rolling land. This condition has caused severe problems to transport and construction.

In the summer, Arctic climate can be surprising. In July and August rain has fallen on the North Pole, and excepting Greenland,¹⁸ more than 90 per cent of all Arctic land is snow-free in August. Fort Smith, a sub-Arctic community on the Slave River in Canada has had temperatures as high as 103⁰ F., and the average July temperature is 62⁰ F.

The Arctic is becoming warmer. It is estimated that in some regions the climate has moderated at the rate of one degree in ten years. Walrus and white whales are not traveling as far south as before; halibut and other fish are moving further north, and glaciers are slowly melting,¹⁹ although glaciologists say this is just a short-term trend as the world is still recovering from the last ice age.

An interesting observation regarding this warm-up is to compare the 1937-40 drift of the Soviet ship "Sedov" across the Arctic Sea with that of the "Fram" along a similar route some 40 years earlier. The "Sedov" took only two-thirds the time, and experienced an annual mean air temperature seven degrees F. higher than the "Fram" and a winter mean temperature 14⁰ F. higher. The increased speed of drift indicates stronger winds and more broken ice--both evidence of increased storminess, which results from more warm air coming into the Arctic.

The transit of these two ships while frozen into the ice pack, coupled with many observations from the recent ice-floe stations have fully demonstrated that there is a definite movement of the Arctic ice in a clockwise direction. For example, an ice-floe station manned north of Baffin Island will

¹⁷ The Sahara Desert averages 1 to 8 inches and the Gobi Desert 1 to 12 inches, compared to northeastern United States with 30 to 40 inches annual precipitation.

¹⁸ The Greenland icecap, some 700,000 square miles in extent, is the largest ice mass in the world with the exception of Antarctica.

¹⁹ Some glaciers are growing--where there is milder climate with more rain and snow.

tend to move westward along the Canadian Arctic toward Alaska and then around the length of the Eurasian mainland past Franz Josef Land and will finally funnel into the strait between Spitzbergen and Greenland. The ice drift speeds up as the force of the Greenland current, which carries ice and water out of the central Arctic through the strait, begins to make itself felt.

Even in winter the ice floes move. There are no vast expanses of ice but billions of cakes ranging in area from the infinitesimal to several hundred square miles. When the floes break up during the summer they remain separate until autumn, dividing and redividing.

In October 1959 a Soviet radio broadcast outlined an audacious plan to melt the Arctic ice and change the entire climate of the Northern Hemisphere. The scheme, suggested by a Soviet power engineer at the Soviet Academy of Sciences, Arkady Markin, would involve the close co-operation of the United States and the Soviet Union to participate in building a gigantic dam across the Bering Straits (the narrow neck of water separating the eastern tip of Siberia from Alaska).

His plan calls for the installation of thousands of propeller pumps in the body of the dam, the use of nuclear power to drive them and the pushing by the pumps of the warm Pacific current into the Atlantic via the Arctic Sea. This would gradually increase the temperature of the Arctic Sea, melt the ice, and cause a resultant climatic change for Siberia and North America, converting the now frozen areas into temperate and productive regions. Although this scheme has drawn much caustic comment because of the immense technical problems involved, it is typical of the kind of daring thinking that has in past decades characterized Arctic pioneers.

Antarctica: An Almost Lifeless Desert

Straddling the "bottom" of our world is the Antarctic continent, a huge ice-topped land mass. Because of its circumpolar position Antarctica and its surrounding oceanic waters have unique physical and biological phenomena. As Gould has stated, "the ordinary directional expressions 'east' and 'west' have little relevance in describing Antarctic phenomena. No matter along what meridian one approaches the continent, one passes through essentially the same climatic and life zones, ending with the same inland ice."²⁰

The tree line system of defining the Arctic is of no use in delimiting the south polar region, as all of Antarctica lies outside the limit of trees. Although some consider the Antarctic Circle (66° 30' South latitude), which roughly parallels the isotherm of 32° F. for the warmest month, to be a satisfactory boundary between the Antarctic and sub-Antarctic, the "Antarctic Convergence" is generally regarded as the best defined boundary.

²⁰ Gould, Laurence M., "Antarctic Prospect," The Geographical Review, Vol. 47, No. 1, 1957.

The Convergence, which approximately parallels the isotherm of 50° F. for the warmest month, is an unbroken and rather sharply defined oceanic boundary around the continent of Antarctica. It is caused by the collision of the northward-moving Antarctic cold waters with the considerably less dense sub-Antarctic waters. The colder Antarctic current sinks with little mixing with a resultant and obvious sharp change in sea and air temperatures and the character of plankton and sea birds.²¹

Southward the next natural boundary is the northern fringe of the pack ice which surrounds the continent. In winter the sea freezes over for several hundred miles beyond the Antarctic coastline, but, in summer most of the ice breaks up and drifts away, providing open avenues for the entrance of ships.

The great embayments of the Ross and Weddell Seas break the almost circular outline of the continent, and also point out its division into two major natural areas: West Antarctica, lying almost wholly in the Western Hemisphere, and East Antarctica, which includes the rest of the continent. East Antarctica is twice as large, and the ice plateau covering it rises to heights of more than 14,000 feet, while the average ice cover for West Antarctica is approximately 7,000 to 8,000 feet in altitude.

Observations carried out during the IGY indicate that much of West Antarctica is actually an archipelago of islands bridged over by ice. East Antarctica, however, is still thought to be a large plateau similar to those found in other continents. It has a vast mountain range that rises almost everywhere above the ice cover.

With all their geological differences East and West Antarctica are together covered by the vast uniform inland ice sheet, which lies over 99 per cent of the land itself, and which with its seaward extensions covers an area several thousands of square miles larger than the continent.

This ice which has accumulated over thousands of years (at a current rate, however, of only about one foot per year) is, in some places, more than 10,000 feet thick. The great weight of this ice causes it to push out toward the edges of the continent in the form of glaciers. When it reaches the ocean, the ice moves out across the sea in the form of ice shelves. These shelves, which are still attached to the land at one end, are peculiar to the Antarctic continent and constitute the largest floating masses of ice on earth. They are flat-topped and usually two-thirds submerged.

The largest of these shelves, the Ross Ice Shelf, averages 350 miles in width and covers an area of 200,000 square miles--about as large as France. Occasionally pieces of ice break off and float northward--these are the distinctive tabular Antarctic icebergs.

²¹ In the summer the resultant change of air temperature averages from $7-11^{\circ}$ F., and is readily felt aboard ship.

Antarctica has the severest continental climate on earth, substantially colder than the Arctic. Although the average annual mean temperature at the United States station at the South Pole is -56°F. , the lowest temperature ever recorded on earth was -124°F. --at the Russian station Sovietskaya, located several hundreds of miles to the north, but at a much greater altitude, and further away from the sea.

At the edge of Antarctica temperatures are considerably warmer than inland on the icecap. The United States Wilkes Station, for example, has summer temperatures during December, January, and February averaging 30°F. and has an average annual temperature of only 15°F. The lowest temperature ever recorded at Wilkes is but -36°F. The difference in average annual temperature between Wilkes and the South Pole (some 73°F.) is more than the difference between Miami and the Canadian Arctic.

An important feature of Antarctic weather is the wind that blows almost continuously. Air, cooled by the frigid inland ice sheet, flows down from the plateau, at times gaining a velocity of 90 mph for an entire day with gusts up to 200 mph. At several Antarctic coastal stations the average annual wind velocity is more than 40 mph.

Unlike the Arctic with its abundance of flora and fauna Antarctica has no polar bears, no reindeer, no trees, and only two flowering plants and a few mosses and lichens which cling to exposed rocks. The largest land animal is a wingless mosquito. But, if the Antarctic land cannot support life, the waters between the continent and the Antarctic Convergence can. Nowhere else in the world is found such plentitude of life per square acre. This richness is directly traceable to the abundance of nitrates and phosphorus brought to the surface by the continually upwelling waters. Bird life is essentially marine, with three indigenous species: the emperor penguin, the Adelie penguin, and the skua gull.

Conclusions

The significance of the polar areas as current strategic and future economically important areas has become evident in a very short time. In just 15 years the defense posture of the United States has been focused on the Arctic with a strong subsidiary development of scientific research activity in both polar regions.

The highly successful internationally co-ordinated organization and dramatic execution of the multination IGY program in the Arctic and in Antarctica has happily resulted in the awakening of national response in many countries to the needs of basic research. The provision by a dozen countries for long-term Antarctic programs is testimony to the success of the IGY in bringing the polar regions into national focus.

It is to be hoped that the startling technological developments of the

past few years will open up the polar areas as never before. The development of commercial polar air routes may soon be matched by the use of fleets of nuclear-powered submarine cargo carriers capable of traversing the Arctic Sea under the ice at any time of year. The use of packaged atomic power reactors, already scheduled for 1962 operation at two United States Antarctic stations, will greatly speed, and in many cases make possible, the settlement of both the polar areas and their increased economic exploitation.

Finally, the successful conclusion of the 12-nation Antarctic Treaty in 1959, with its revolutionary provisions for unilateral inspection and the banning of all nuclear explosions may well prove to be a forerunner of similar agreements on other problems facing the world--such as disarmament and future international accords regarding the utilization of space.

John Hanessian Jr

A READING LIST OF RECENT AUFS REPORTS ON THE POLAR REGIONS

- | | |
|-----------|--|
| JH-1-'60 | EXPEDITIONS POLAIRES FRANCAISES |
| Apr. 1960 | A report written by Mr. Hanessian while he was a Fellow of the Institute of Current World Affairs and which was distributed by the Institute as Newsletter JH-14. (26 pp.) |
| JH-2-'60 | THE ANTARCTIC TREATY |
| July 1960 | An analysis of the provisions of an extraordinary international treaty up for ratification by 12 countries. (15 pp.) |

OTHER SUGGESTED READINGS ON THE POLAR REGIONS

"The Antarctic." Parliamentary Debates, Hansard. (House of Lords, Official Report, Vol. 221, No. 40, 18 February 1960, London, H.M.S.O., Columns 158-191.) Account of an interesting debate re the Antarctic Treaty.

Armstrong, Terence. The Russians in the Arctic. (London: Methuen, 1958, 182 pp.) Covers various aspects of Soviet exploration and use of the far north from 1937-57; including chapters on Arctic archaeology and Soviet Arctic peoples.

Congress, House of Representatives, Committee on Interstate and Foreign Commerce. International Geophysical Year, the Arctic, Antarctica, Report of the (Washington, D. C.: House Report No. 1348, 85th Congress, 2nd session, February 17, 1958, 1958, 182 pp.) Includes comprehensive report of all United States activities in the polar regions during the IGY.

Euller, John. Arctic World. (New York: Aberlard-Schumann, 1958.) A general history of Arctic exploration and research, 1900-57.

Gould, Laurence M. "Antarctic Prospect." The Geographical Review. (New York: January 1957, 47 [1] pp. 1-28.) Discussion of gradual shrinkage of unknown territory in Antarctica with an excellent series of maps; geography, climate, geology, mineral deposits, flora and fauna, and work during the IGY.

-----. Antarctica in World Affairs. (New York: Foreign Policy Association Headline Series No. 128, March-April 1958, 54 pp.) An interesting and readable general statement by the Director of the United States Antarctic Program during the IGY.

-----. "Strategy and Politics in the Polar Areas." Annals of the American Academy of Political and Social Sciences. (Philadelphia: January 1948, [255], pp. 105-114.) Strategic and political considerations.

Hackworth, Green H. "Polar and Sub-polar Regions." Digest of International Law. (Washington, D. C.: G.P.O., 1940, Vol. I, pp. 449-465.) Outstanding contribution; survey of applicable international law using basic United States diplomatic documents.

Hanessian, John, Jr. "The Antarctic Treaty, December 1959." International and Comparative Law Quarterly. (London: July 1960.) Comprehensive discussion of the history of efforts to internationalize the Antarctic since 1947 and culminating with a documented analysis of the Antarctic Treaty and the negotiations preceding it.

- , "Antarctica, Current National Interests and Legal Realities." Proceedings of the American Society of International Law. (Washington, D. C.: 1958, pp. 145-164.) Detailed, documented discussion of the various national policies as of 1958; review of steps in internationalization especially of scientific co-ordination from 1954-58.
- Hayton, Robert D. "The American Antarctic." American Journal of International Law. (Washington, D. C.: July 1956, 50 [3], pp. 583-610.) Well-documented analysis of the position of each of the three claimant nations.
- , "The Antarctic Settlement of 1959." American Journal of International Law. (Washington, D. C.: April 1960, 54 [2], pp. 349-371.) Analysis of the Antarctic Treaty's provisions and discussion of the Washington Conference.
- , "Polar Problems and International Law." American Journal of International Law. (Washington, D. C.: October 1958, 52 [4], pp. 746-765.) Good documented survey of recent political developments regarding both polar areas.
- Hunter Christie, E. W. The Antarctic Problem: An Historical and Political Study. (London: Allen & Unwin, 1951, 336 pp.) An important study; emphasizes the conflicting Argentine-British-Chilean claims and discusses possible solution.
- Hyde, Charles Cheney. "Acquisition of Sovereignty Over Polar Areas." International Law Chiefly as Interpreted and Applied by the United States. (Boston: Little Brown & Co., 2nd ed., I, 1945, pp. 347-355.) Important contribution by an American jurist; criticizes use of sector theory; adapted from his classic article in the Iowa Law Review, January 1934, 19 [2], pp. 286-294, same title.
- International Court of Justice, Pleadings, Antarctica Cases, United Kingdom v. Argentina, United Kingdom v. Chile. (The Hague, 1956, 114 pp., in both French and English.) Includes an elaborate and comprehensive British statement justifying its claim.
- Jenks, C. Wilfred. "An International Regime for Antarctica." Chapter 8 of his The Common Law of Mankind. (London: Stevens & Sons, 1958, pp. 366-381, also published by Fredrick A. Praeger, New York, 1958, 456 pp.) An especially valuable discussion of possible settlements by a thoughtful British international lawyer--expanded from his article of the same title in International Affairs, London: October 1956, 32 [4], pp. 414-426.

- Jessup, Philip C. and Taubenfeld, Howard J. Controls for Outer Space and the Antarctic Analogy. (New York: Columbia University Press, 1959, see Part II, pp. 135-190 "International Controls for the Antarctic.") Provocative analysis of possible international solutions; comprehensive, annotated bibliography.
- Joerg, W. L. G. The Geography of the Polar Regions. (New York: American Geographical Society Special Publication No. 8, 1928, 359 pp.) An important early contribution; two sections written respectively by Otto Nordenskjold and Ludwig Mecking.
- Kirwan, L. P. The White Road. (London: Hollis & Carter, 1959.) Excellent historical survey of both polar regions together; includes discussion of motives and conflicts of expeditions at home, valuable and readable account by the Director of the Royal Geographic Society, London.
- Neatby, L. H. In Quest of the Northwest Passage. (Toronto: Longmans Green, 1958.) A recent popular account.
- Rodahl, Kaare. North. (New York: Harper & Bros., 1953.) Interesting general review with emphasis on activities on ice island T-3.
- Simpson, Frank A., ed. The Antarctic Today, a Mid-Century Survey of the New Zealand Antarctic Society. (Wellington: New Zealand Antarctic Society, 1952, 389 pp.) Still the best statement of the state of knowledge about Antarctica; chapters by various experts on their field.
- Sullivan, Walter. "Antarctica in a Two-Power World." Foreign Affairs. (New York: October 1957, 36, pp. 154-166.) An interesting and thoughtful analysis of United States political policies and activities re Antarctica; discusses recent claim developments and settlement alternatives.
- , Quest for a Continent. (New York: McGraw Hill, 1957, 373 pp.) History of Antarctic exploration with emphasis on United States activities.
- Svarlien, Oscar. "The Legal Status of the Arctic." Proceedings of the American Society of International Law. (Washington, D. C.: 1958, pp. 136-143.) Exposition by a well-known American academician; talk given before the 1958 annual meeting of the Society.
- Taracouzio, T. A. Soviets in the Arctic, an Historical, Economic and Political Study of the Soviet Advance into the Arctic. (New York: Macmillan, 1938, 563 pp.) Soviet penetration, international significance; with extensive bibliography and appendixes. This is an important work in English.

"Text of the Antarctic Treaty." Department of State Bulletin. (Washington, D. C.: December 21, 1959, 41 [1069] pp. 911-917.) Includes texts of Final Act, the Treaty, and statements by President Eisenhower and the Secretary of State.

Toma, Peter, A. "Soviet Attitude Towards the Acquisition of Territorial Sovereignty in the Antarctic." American Journal of International Law. (Washington, D. C.: July 1956, 50, pp. 611-626.) Excellent discussion with Soviet source material of the international legal aspects of Soviet Antarctic policy; well documented.

"United States Proposes Conference on Antarctica." Department of State Bulletin. (Washington, D. C.: June 2, 1958, 38 [988] pp. 910-912.) Includes text of Eisenhower's Note and the White House Press Release of May 3, 1958.

Waldock, C. H. M. "Disputed Sovereignty in the Falkland Islands Dependencies." British Yearbook of International Law. (London: 1948, 25, pp. 311-353.) Careful and most reasoned analysis yet published of Britain's conflicting claims with Argentina and Chile.

* * * * *